THE

FIRST INTERSTELLAR EXPLORER:

WHAT SHOULD IT DO WHEN IT ARRIVES AT ITS DESTINATION?

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With a lot of help from
JPL's A-Team

MISSION PHASES AND DECISION POINTS

In the Encounter Phase, our Explorer will essentially be on its own

APPROACH & ENCOUNTER

MISSION OPTIONS

Analogy is Hubble and New Horizons @ Pluto

Key Question is: How much do we expect to learn before our Explorer arrives?

HIGH

MINUTES

NO BRAKING
PASS BY ***0.1-0.2 LIGHT SPEED***

MEDIUM

HOURS

SLOW DOWN
LIKE ***NEW HORIZONS***

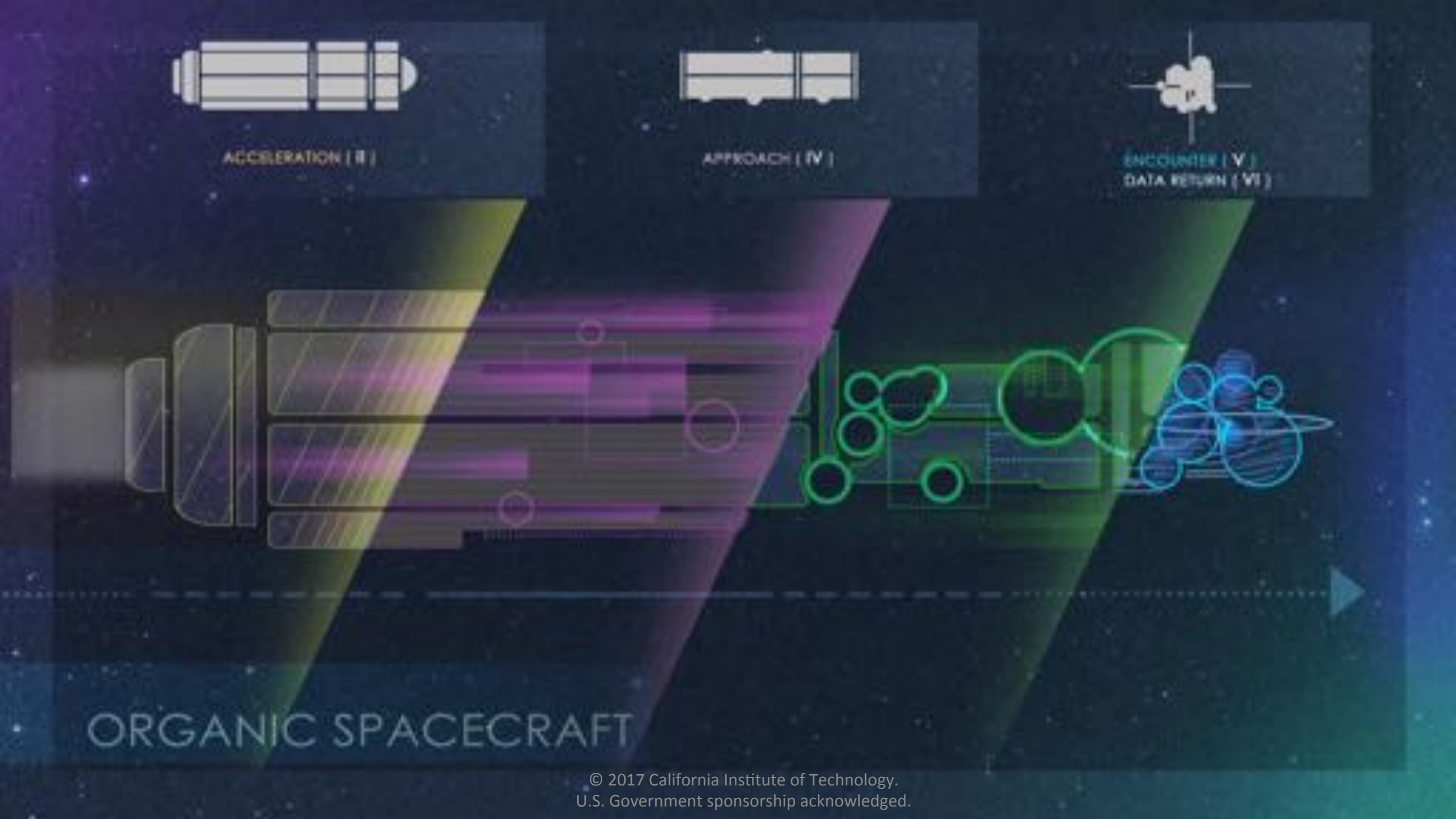
LOW

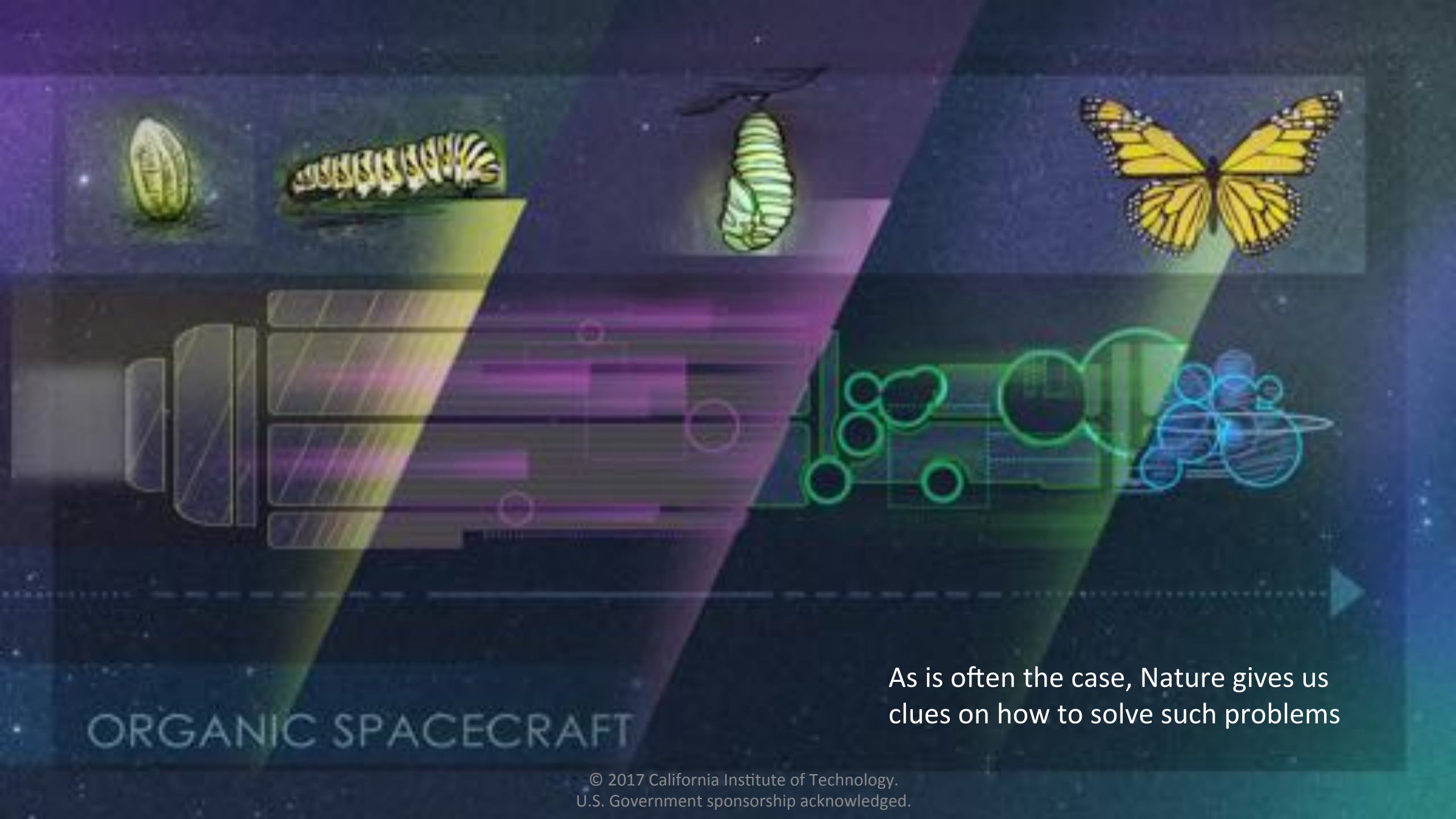
YEARS

ENTER ORBIT
LONG TERM

MISSION ENCOUNTER
PHASES

Science Value increases
as Relative Velocity slows





As is often the case, Nature gives us clues on how to solve such problems

SUPPORT MISSION

EARTH SUN

PRIMARY MISSION

GRAVITY LENS

550 AU

270,000 AU

WITH GRAVITY LENSING

1,000 x 1,000 pixels

FULL ENCOUNTER

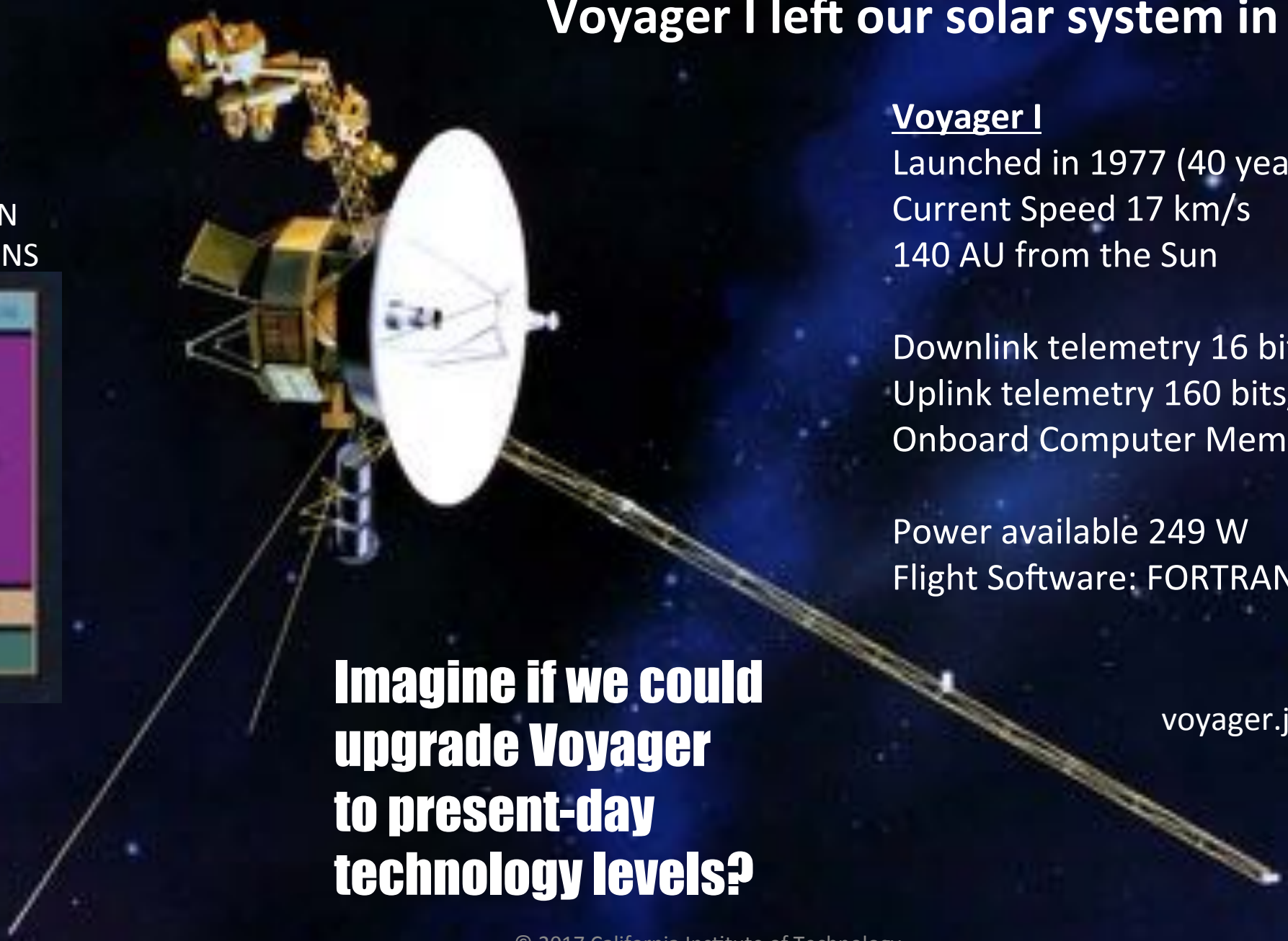
DATA RETURN

OPTICAL COMM ENHANCED BY GRAVITATIONAL LENSING?

MORE CONVENTIONAL RF? ~~QUANTUM ENTANGLEMENT?~~

Voyager I left our solar system in 2012

MISSION FUNCTIONS



Voyager I
Launched in 1977 (40 years ago!)
Current Speed 17 km/s
140 AU from the Sun

Downlink telemetry 16 bits/sec
Uplink telemetry 160 bits/sec
Onboard Computer Memory 70 kBytes

Power available 249 W
Flight Software: FORTRAN/C

Imagine if we could upgrade Voyager to present-day technology levels?

voyager.jpl.nasa.gov

FLIGHT HARDWARE UPGRADES @ 4 LY

3-D PRINTER

+

MINERAL STOCKS

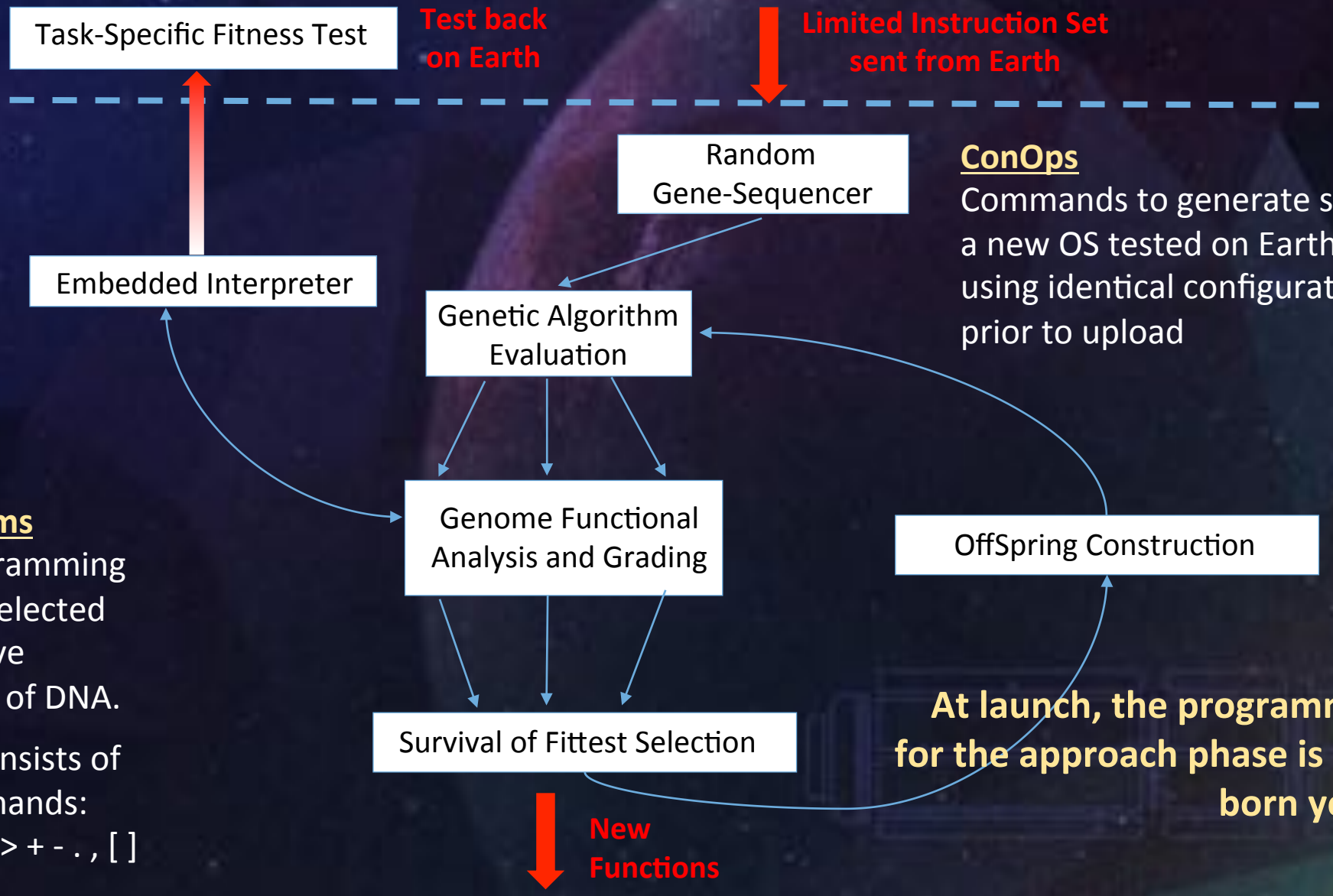
=

NEW COMPONENTS

Tap into the creative juices of the entire world through competitions to design upgrades using limited resources

FLIGHT SOFTWARE UPGRADES @ 4 LY?

AI Programming
- uses genetic algorithms coupled with a tightly constrained programming language that minimizes the overhead of its Machine Learning search space.



ConOps
Commands to generate say a new OS tested on Earth using identical configuration prior to upload

Genetic Algorithms
- A series of programming instructions are selected at random to serve as an initial chain of DNA.

Instruction set consists of just 8 basic commands:

< > + - . , [ ]

At launch, the programmer for the approach phase is not born yet…

Acknowledgment: Becker, K., and Gottschlich, J., AI Programmer: Autonomously Creating Software Programs Using Genetic Algorithms, arXiv:1709.05703, arXiv.org (2017)

FINAL THOUGHTS

- In conceptualizing the First True Interstellar Explorer, we have to **think about the mission in a very different way than we are used t**o
- Highly likely that we learn a lot remotely about its destination **while en route**, changing the mission's fundamental objectives
  - *Imagine trying to predict what science we would want to do for any body in our own solar system 4 decades from now*

- During the final encounter phase, our Explorer will be essentially on its own
- To fit the functions appropriate to each mission phase, the spacecraft will probably need to **reconfigure along the way**
- The ability to send H/W and S/W Upgrades, making the most of limited resources on board our Explorer, could unlock enormous creativity back here on Earth
- If we use organic materials, what are the implications for Exo-Planetary Protection?